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Welcome from the General Chairs

Welcome to the 11th International Conference on Intelligent Systems Design and Applications (ISDA'11) that this year takes place in Cordoba, November 22-24. Cordoba is located in the region of Andalusia, in southern Spain, with more than two thousand years of history. Its old town contains numerous reminders of when it was the capital of Hispania Ulterior during the time of the Roman Republic and the capital of Hispania Baetica during the Roman Empire. Cordoba was also during the 10-11th centuries the capital of the Islamic Caliphate of Cordoba that included most of the Iberian Peninsula. In these times Cordoba was the most populous city in the world and the intellectual center of Europe. Today it is a medium size city with a population of about 350,000 that mantains an enormous cultural and monumental patromony as heritage of their ancestors.

The University of Cordoba is witness to this entire cultural heritage, while the passion for knowledge, respect, universal projection and harmony among civilizations make the city that houses our institution a paradigm for humanity. This equilibrium and harmony is reflected in the three broad areas in which the UCO undertakes its activities: the Agricultural and Food Sciences, Science and Technology; Humanities and Legal and Social Sciences and the Health Sciences; each with its own special characteristics. This balance is also manifested in quality teaching and research, situating it among the top academic institutions in Spain.

ISDA'11 is organized and sponsored by the Machine Intelligence Research Labs (MIR Labs), the University of Cordoba (Spain), and the Ministry of Science and Innovation of Spain. Technically it is sponsored by the IEEE Systems, Man and Cybernetics Society; the IEEE (Spain Section); the IEEE Systems, Man and Cybernetics Society (Spanish Chapter); International Fuzzy Systems Association (IFSA); European Neural Networks Society (ENNS); the European Society of Fuzzy Logic and Technology (EUFLAT); the World Federation of Soft Computing (WFSC) and Technically Supported by the IEEE Systems, Man and Cybernetics Society Technical Committees on Soft Computing and Granular Computing.

ISDA'11 brings together researchers, engineers, developers and practitioners from academia and industry working in all interdisciplinary areas of intelligent systems and system engineering to share their experiences, and to exchange and cross-fertilize their ideas. The aim of ISDA'11 is to serve as a forum for the dissemination of state-of-the-art research and development of intelligent systems, intelligent technologies, and applications.

This year we received 394 papers, from 51 countries, of which 237 have been accepted. All submissions were reviewed by three reviewers, with no distinction between papers submitted for special sessions, workshops, or as regular papers. We are convinced that the quality and diversity of the topics covered will satisfy both the attendees and readers of the conference proceedings. We are pleased to announce these outstanding plenary speakers:

- Prof. Bernard De Baets, *Ghent University, Belgium*
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We express our sincere thanks to the Programme Chairs: Profs. Jose Manuel Benitez, Francesco Marcelloni, and Cristobal Romero, for arranging the very rich technical programme. We also express our gratitude to the workshop and special session organizers, and all the program committee members who reviewed the papers and made the ISDA'11 a very successful conference. We will be welcoming you in Cordoba and hope that you will enjoy the conference programme.

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SS17 – Special Session on Linguistic Data Summarization
GS06-1 – Intelligent Control and Automation
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Multiagent Systems and self-organizative virtual organizations, a step ahead in adaptive MAS

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Abstract— **Organizations of agents based on Virtual Organizations needs to be supported by a coordinated effort that explicitly determines how the agents should be organized and carry out the actions and tasks assigned to them. The interactions of a multi-agent system cannot be only related to the agent and the communication skills, but also to the concepts of organizational engineering. Moreover, nowadays there is a clear trend towards using methods and tools that can help to develop and simulate virtual organizations by means of multiagent systems (MAS). Simulation is used for several purposes ranging from work flow to system's procedures representation. The contribution from agent based computing to the field of computer simulation mediated by ABS (Agent Based Simulation) is a new paradigm for the simulation of complex systems that require a high level of interaction between the entities of the system. The main goal of this work is a new global coordination model for an agent organization in a simulation context. The innovation of this work consists of the dynamic and adaptive planning capability to distribute tasks among the agent of the organization. The middleware used for simulation makes it possible to visualize the emergent agent behaviour and the entity agent.**

Keywords- Multi-Agent systems, Virtual Organization, Dynamic Architectures, Simulation, Planning, Adaptive Environments

I. INTRODUCTION

The development of open MAS is still a recent field of the multi-agent system paradigm and its development will allow applying the agent technology in new and more complex application domains [1][2]. However, this makes it impossible to trust agent behavior unless certain controls based on norms or social rules are imposed. To this end, developers have focused on the organizational aspects of agent societies, using the concepts of organization, norms, roles, etc. to guide the development process of the system.

Virtual organizations [3] are a means of understanding system models from a sociological perspective[4][5][6]. From a business perspective, a virtual organization model is based on the principles of cooperation among businesses within a shared network, and exploits the distinguishing elements that provide the flexibility and quick response capability that form the strategy aimed at customer satisfaction. Even so, within the development of organizations, both at the business and agent level, we find a set of requirements [7][8] that call for the use of new social models in which the use of open and adaptive systems is possible.

The contribution from agent based computing to the field of computer simulation mediated by ABS (Agent Based Simulation) is a new paradigm for the simulation of social models that require a high level of interaction between the entities of the system. Possible benefits of agent based computing for computer simulation include methods for evaluation of multi agent systems or for training future users of the system [9]. Many new technical systems are distributed systems and involve complex interaction between humans and machines, which notably reduce their usability. The properties of ABS makes it especially suitable for simulating this kind of systems. The idea is to model the behavior of the human users in terms of software agents. However, it is necessary to define new middleware solutions that allow the connection on ABS a simulation software.

Given the advantages provided by the unique characteristics found in the development of MAS from an organizational perspective, and the absence of an adaptive planning process for any social model, this study proposes a model that can coordinate a dynamic and adaptive planning system in an simulated agent organization.

The development of the model enables the use of information to improve the allocation tasks. The proposed notions will be validated via the development of an experimental system consisting of a planning model located at each of the participating agents.

The article is structured as follows: Section 2 describes the background for current studies of the agents, virtual organizations and its adaptation. Section 3 presents the proposed planning model. And finally, Section 4 demonstrates how the model can be used in a simulated case study and some conclusions and experimental results.

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II. BACKGROUND

Agents and multiagent systems (MAS) are adequate for developing applications in dynamic and flexible environments. Autonomy, learning and reasoning are especially important aspects for an agent. These capabilities can be modelled in different ways and with different tools [10].

Nowadays, there are several different organizational approaches [9] [1]. However, while these studies provide mechanisms for creating coordination among participants, there is much less work focused on adapting organizational structures in execution time or norms defined in design time. For example, [11] proposes a model for controlling adaption by creating new norms. [12] propose a distributed model for reorganizing their architecture. [13] requires agents to follow a protocol to adapt the norms. Each of these studies focuses on the structure and/or norms based on adapting the coordination among participants. Another possibility is the development of a MAS that focuses on the concept of organization/institution. One electronic institution [14] should be considered a social middleware between the external participating agents and the selected communication layer responsible for accepting or rejecting the agent actions. The primary difference with the other proposals is that the adaption is carried out by the institution instead of by the agents. Lastly, there are approaches focus on social group mechanisms based on the social information gathered during the interactions [15].

None of these approaches is capable of coordinating tasks for the member agents of the organization to solve a common problem, nor do them consider that task planning should adapt to changes in the environment. The architecture selected for this study is OVAMAH [16][17][4], which focuses on defining the structure and norms. The following section will present the planning model proposed integrated into OVAMAH whose goal is to carry out an adaptive planning process within an agent organization.

The architecture is essentially formed by a set of services that are modularly structured. OVAMAH uses the FIPA architecture, expanding its capabilities with respect to the design of the organization, while also expanding the services capacity. OVAMAH has a module with the sole objective of managing organizations that have been introduced into the architecture.

In this work, to carry out experiments that prove the efficiency of the proposed planning model, it has been added an additional module that provides simulation, visualization and analysis of the agent' behavior [18]. This module makes use of technologies for the development of multiagent systems known and widely used [19][20], and combines them so that it is possible to use their capabilities to build highly complex and dynamic systems. It is a middleware infrastructure to simulate intelligent agents with visualization, simulation and analysis capabilities [18].

III. PLANNING MODEL

In this research is proposed a planning model that facilitates a self-adaptation feature within an agent society. We will use a cooperative MAS in which each agent is capable of establishing plans dynamically in order to reach its objectives. The global mechanism considers the global objective of the society, as well as its norms and roles. It's obtained a planning model that can, within an architecture geared towards the development of agent organizations (OVAMAH [16][17]), take into account the changes that are produced within an environment during the execution of a plan. The planning process defines the actions that the society of agents will have to execute and should therefore also take into account the particular circumstances of each of its members. To achieve this, a CBP-BDI (Case Based Planning) agent is used, applying the planning model showed in this section, that is particularly suited for organizations. A CBP-BDI agent is a specialization of an CBR-BDI agent [21][7]. A CBP-BDI agent calculates the plan or intention that is most easy to replan: Most RePlannable Intention (MRPI). This is the plan that can most easily be replaced by another plan in case it is interrupted (for example, if a user changes preferences while the plan is being executed.

A plan p within an organization is defined as $p=<E, O, O', R, R'>$, where: E is the environment that represents the type of problem that the organization solves, and is characterized by a set of states $E = \{e_0, e^*\}$ for each agent, where e_0 represents the initial state of the agent when the plan begins, y and e^* is the state or set of states that the agents tries to achieve. O represents the set of objectives for the individual agent and O' is the set of objectives reached once the plan has been executed. R is the set of available resources for the given agent and R' is the set of resources that the agent has used during the execution of the plan.

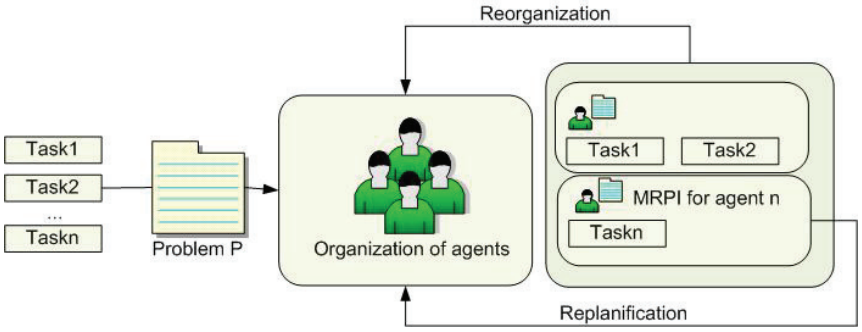

Figure 1. Planning Model.

Given the initial state of the organization, the term *global planning* is used to describe the search for a solution that can reach the final state, all the while complying with a series of requirements for the organization. The problem can be represented in a planning space that is delimited by the restrictions imposed by the requirements. Given a common objective, specified resources available and tasks to perform, the aim is to find a global plan that allows the organization to find the optimal solution, To this end, the planning agent should bear in mind the optimal plans *p*(t)* obtained for each individual agent. It is not necessary for all of the agents within the organization to know how to meet the objectives, but they should know how to perform some of the tasks that contribute towards reaching those objectives for the organization.

Upon initiating the process, certain agents will be retrieved from the data memory of cases to perform at least one of the problem tasks. For each task that is not completed by any of the retrieved agents, at least one new agent will be incorporated. This agent will have the greatest probability of successfully completing the given task. The idea is to count on the necessary agents so that no task is left unassigned.

Let us assume that the common objective for agents "m" has "n" states or tasks with $m,n \in N$. Each agent has its own characteristics with regards to which tasks it can perform, which resources to use, and the amount of time available to perform the tasks. In other words, each agent has its own profile. Given a state "j" for each agent "i" where $i \in \{1,\cdots,m\}_{m\in N}$, it can be defined with a tuple z_{ij} - where each coordinate in the tuple refers to the characteristic that defines it.

The following binary variables are defined as:

$$a_{ij} = \begin{cases} 1 \text{ if agent "i" is assigned to task "j"} \\ 0 \text{ otherwise} \end{cases}$$

For each problem related to assigning tasks, an objective function is defined whose goal is to minimize and maximize the cost used by agents "m" to perform the common objective. For example, minimize or maximize the cost of using one of the agents to reach an objective, or maximize an efficiency function as need for each case. A new efficiency function is introduced in order to assign tasks to the agents. Its aim is to perform the greatest number of tasks with the lowest possible cost. *Cost* is another function that depends on the time that agent "i" has spent working on task "j", on the resources used, and on the type of agent assigned to each task. This is represented as: $c^i_{t_{ij}r_j}$.

The efficiency function is defined as:

$$Efficiency = Nº\ Task\ performed \,/ \sum_{i=1}^{m}\sum_{j=1}^{n} c^i_{t_{ij}r_{ij}} \bullet a_{ij}$$

Let us assume we want to maximize the efficiency function:

$$Max \cdot Nº\ Task\ performed \,/ \sum_{i=1}^{m}\sum_{j=1}^{n} c^i_{t_{ij}r_{ij}} \bullet a_{ij}$$

where t_{ij} is the time it takes agent "i" to perform the task, and $t_{ij} = \underset{k}{Máx}\{t_{ijk}\}$ where t_{ijk} indicates the time it takes a first agent "i" to perform task "j" for a second agent "k". Taking the maximum value of "k" (type of the second agent), we can ensure that the first agent has time to perform the necessary task regardless of the type of the second agent. These times are initially estimated. Let us now define the restrictions of the problem.

1) We want each state to be completed by an agent, which in mathematical terms can be stated, for each state "k" as:

$$\sum_{i=1}^{m} a_{ik} = 1 \quad \forall k \in \{1,\cdots,n\}$$

2) We want each state to be completed within a specified period of time. Let us assume that state "k" should be completed within time t_k. The restriction would be:

$$\sum_{i=1}^{m} t_{ik} a_{ik} \le t_k \quad \forall k \in \{1,\cdots,n\}$$

3) Each state "k" needs a set of resources to be executed. There is no reason for all of the agents to have these resources.

Given state "k", we need r^k_h resources with $h \in N$, where

$$r_w = \max\{r^k_h\}^{k=1,\cdots,n}_{h\in N}.$$

The variables $\{r^k_x\}_{x\in\{1,\cdots,w\}} \quad \forall k \in \{1,\cdots,n\}$ are defined in binary form:

$$r^k_x = \begin{cases} 1 \text{ if the agent "k" needs the resource "x"} \\ 0 \text{ otherwise} \end{cases}$$

The agent that performs state "k" must at the very least have at its disposable the resources that are needed to perform state "k", for which, given state "k", for each resource from the set $\{r_x^k\}_{x\in\{1,\cdots,w\}} \quad \forall k\in\{1,\cdots,n\}$ we can define the following restriction:. $\sum_{i=1}^{m} r_{ix}a_{ik} \geq t_x^k \quad \forall k\in\{1,\cdots,n\};\forall x\in\{1,\cdots,w\}$. The variables $\{r_{ix}\}_{x\in\{1,\cdots,w\}} \quad \forall i\in\{1,\cdots,m\}$ are binary variables:

$$r_{ix}=\begin{cases}1 \text{ if the agent "i" has the resource "x"}\\ 0 \text{ otherwise}\end{cases}$$

4) Each agent "i" has a minimum and maximum time for work, depending on the type of agent. These times are represented as $t_i^{Turn\ on}$ and $t_i^{Turn\ off}$ respectively:

$$t_i^{Turn\ on} \leq \sum_{j=1}^{n} t_{ij} \leq t_i^{Turn\ off} \quad \forall i\in\{1,\cdots,m\}$$

For the majority of agents, as we will see in the case study, the maximum number of working hours is equal to a regular 8 hour work day.

5).Every time we assign tasks to an agent, we want it to perform the minimum number of tasks, which varies according to the type of agent:

$$\sum_{j=1}^{n} a_{ij} \geq NumberTask_i \quad \forall i\in\{1,\cdots,m\}$$

.

If the suggested problem of non-linear programming were incompatible, we would add agents to make it compatible. The agent added would be the one with the highest probability a priori of performing the necessary tasks. If a norm (restriction) changes, it would be necessary to assign tasks once again. This allows us to obtain a plan for the tasks that need to be performed by the agent organization. In other words, we can obtain a global plan composed of all the tasks and agents in the organization that will carry them out. Every agent in the organization recognizes the tasks that it needs to perform. These agents, which are CBP-BDI agents, integrate the 4 phases of a CBR system (retrieval, reuse, revise and retain) [21][7].

IV. EXPERIMENTAL RESULTS AND CONCLUSIONS

This section presents a case study that tests the defined model. The case study delineates the scope and potential virtual organizations in the design and development of simulation systems for deployment in multi-agents environments. An organization is implemented by using the model proposed in section III and is represented in a simulated world [18] containing a set of different tasks.

It has been developed a case study using this middleware to create a multiagent system aimed at facilitating the employment of people with disabilities, so it is possible to simulate the behavior of the agents in the work environment and observe the agents actions graphically in Repast [18][20]. This is a simple example that defines four jobs, which are occupied by four people with certain disabilities. Every job is composed of a series of tasks. Agents representing the workers have to do them, and according to their capabilities, carry out the assignment with varying degrees of success.

The roles that have been identified within the case study are: *Worker* (specialized in *CustomerService, MailHandling, MakingCopie* and *ManagementReports*), *Costumer*, *Coordinator*, *Notification* and *Manager*. The agents that take on the role of Worker are those that will carry out dynamic planning according to the tasks they need to carry out. The generated plans should ensure that all of the workers assigned to a set of task are able to carry out them. They will be personalized according to the Worker´s profile and work habits, and should take into account the restrictions directly related to each agent on an individual basis, as well as the restrictions of the organization itself. These restrictions are imposed according to the norms for the society of agents: (i) the work schedule for a Worker agent (8 hours); (ii) the maximum number of task assigned to a Worker; (iii) number of hours for certain task; (iv) the maximum number of Worker agents that can participate on a global planning; (v) the minimum number of task to make on a global planing.

Once the Coordinator has identified all of the agents in the organization that are needed to carry out the plan, it assigns each task to the agent responsible for completing it. At that moment each Worker agent becomes aware of its tasks and designs an individual plan. Each Worker agent is a type of CBP-BDI agent capable of providing efficient plans in execution time. The following paragraph provides a detailed example.

Let $E_g=\{e_0^g,\cdots,e_h^g\}$ be the tasks carried out by a group of workers "g" in order of priority. We have the following problem $E=\bigcup_g E_g=\{e_0,\cdots,e_n\}$, where E represents the complete set of tasks that must be completed (for this reason they are not superscripted). Let us assume there are 10 workers. Randomly selecting a Worker $i\in\{1,\bullet,10\}$, (specifically, i=3), the task assignment according to their profile is: (1) Agent Task: Serve a customer group 2 $\equiv e_1^2$; t_{31}=30 min. (2) Agent Task: Make 2 reports of customer group 2 $\equiv e_2^2$; t_{32}=45 min. (3) Agent Task: Make 2 copies of reports of customer group 2 $\equiv e_3^2$; t_{33}=10 min. (4) Agent Task: Mail 2 reports of customer group 2 $\equiv e_4^2$; t_{34} =15 min. Calculating the assigned tasks ensures both that the total amount of time assigned to a Worker does not exceed 8 hours, and that any other restrictions corresponding to the norms of the organization are also respected. Each task has a set of objectives that must be met so that the global plan can be successfully completed. To perform each task, the Worker agent should have the number of available resources. For example, the task "Make 2 copies of reports of customer group 2" corresponds to the objective "Attend customers group 2" $\equiv O_0$ or, as another example "breakfast, lunch, tea

and dinner" correspond to the objective $\equiv O_{2,4,6,7}$ (task 2 indicates breakfast, task 4 indicates lunch, task 6 indicates tea, and 7 indicates dinner). A similar coding is used for resources. As shown in Fig. 2a, value 1 indicates the resource that is needed or the objective to be met, while zero denotes the contrary. Fig. 2a shows the representation of a space $\Re^3$ for tasks according to the following three coordinates: time, number of objectives achieved, and number of resources used (coordinates taken from similar retrieved cases).

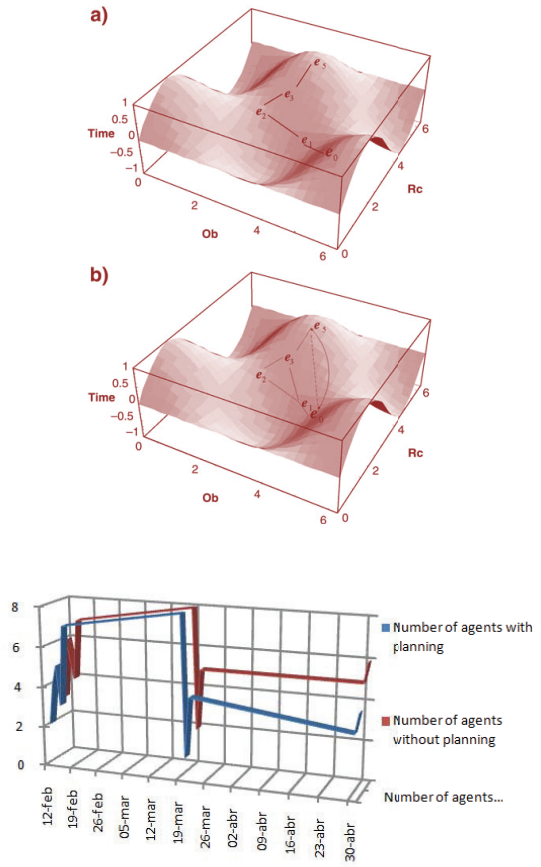

Fig.2 . Representation of a space $\Re^3$ for tasks (a) and replanned tasks (b). Number of agents working simultaneously (c).

Figure 2 illustrates the plan as it was carried out. To understand the graphical representation, let us focus on the initial task e_1 and the final task e_4. In between these two tasks, the Worker agent could carry out other tasks that would involve the same or other costumers. The idea presented in the planning model is to select the optimal plan, the one with the most plans surrounding it, as the solution. The following studies were carried out: Given the same tasks to be made on the same day, and the same number of costumers per group, one simulation used the planner and the other did not.

The results for different days, as far as the number of Worker agents used, can be observed in Fig.2c. The color blue represents the average number of workers needed each day using the planner, and red the number without using it. The proposed model helps the organization utilize fewer workers, thus minimizing its costs.

In conclusion, we can affirm to have achieved out stated objectives: (i) develop agent societies; (ii) simulate the behavior of an organization in a specific case involving the coordination and adaption of its agents; and (iii) validate the proposed planning model through a simulation of the organization in a case study.

As previously mentioned, it is increasingly common to model a MAS not only from the perspective of the agent and its communication capabilities, but by including organizational engineering as well. Performing various simulations, and seeing the evolution in time, the results can be assessed to determine what would be the most suitable job for each worker. Below is an example of the execution of this case study. There are two ways for visualizing multiagent systems simulation: the agents interaction protocol and the agent entity. Our proposal provides the capabilities visualize the sequence of messages between agents and the entity agent and its iteration with the environment. The union of these two platforms [18], JADE [19] and Repast [20], involves having a highly efficient environment for the creation of multiagent systems, getting the benefits of JADE to create the systems, as is the use of FIPA standards; and also the visual representation and extraction of simulation data to different applications provided by Repast.

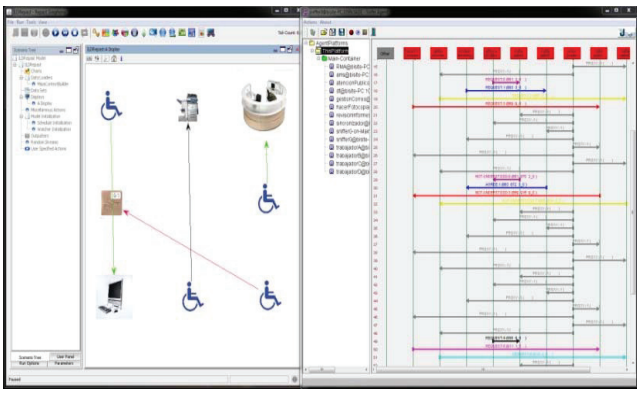

Fig. 3 Case Study

Simulation is a helpful tool for understanding complex problems. Therefore, the simulation of multiagent systems and, in particular, organizations of agents in several levels of details and the emergent behavior is fundamental for analyzing social systems processes.

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